

CLAIMS

1. A float-responsive valve comprising:

(A) a valve body that has a flow passage formed therein, said flow passage
5 having first and second portions;

(B) a valve seat that is disposed in the flow passage between said first and
second portions;

(C) a valve element that is disposed in said flow passage and that is movable
between a closed position in which said valve element seats on said valve seat to prevent
10 fluid flow through said flow passage and an open position in which said valve element
unseats from said valve seat and permit fluid flow through said flow passage; and

(D) a float-responsive valve actuator that is selectively responsive to operation
of a float to move from a first position to a second position in which said valve actuator
holds said valve element in said open position thereof, wherein said valve actuator is
15 dimensioned and configured relative to said valve element such that, when said valve
actuator is in said second position thereof, fluid pressure in said second portion of said
flow passage is essentially incapable of closing said valve element.

2. The float-responsive valve as recited in claim 1, wherein
said valve element comprises one of a poppet and a flapper.

3. The float responsive valve as recited in claim 2, wherein said valve element
5 comprises a flapper that is pivotable between open and closed positions thereof, said

flapper having an upper surface facing said second portion of said flow passage and a lower surface facing said first portion of said flow passage, wherein

said valve actuator comprises an actuating lever that is pivotable about a pivot axis between first and second positions thereof, wherein

10 said actuating lever and said flapper are configured such that, when said actuating lever is in said second position and said lower surface of said flapper is pressed against said actuating lever by closing forces imposed on said flapper by fluid flowing from said second portion toward said first portion, a force vector passes through a primary contact point between said actuating lever and said flapper at a substantially nonnegative angle
15 relative to a bisecting line passing through said pivot axis and said primary contact point.

4. The float-responsive valve as recited in claim 3, wherein said actuating lever has a lobe thereon that at least selectively engages a driven lug on said lower surface of said flapper at said primary contact point.

5. The float-responsive valve as recited in claim 4, wherein said actuating lever is generally L-shaped and has a first leg formed by said lobe, a second leg extending at least generally perpendicularly from said first leg and out of said valve body for attachment to a float, and a pivot mount located at a juncture between said first and second legs.

5

6. The float responsive valve as recited in claim 4, wherein said lever arm is supported on said valve body at said pivot mount.

7. The float-responsive valve as recited in claim 4, wherein said driven lug extends downwardly from a relatively flat bottom surface of said flapper.
8. The float-responsive valve as recited in claim 7, wherein said driven lug is mounted in a segmented recess formed in said bottom surface of said flapper.
9. The float-responsive valve as recited in claim 5, wherein at least one of said lobe and said driven lug has an inclined leading edge that engages the other of said lobe and said driven lug upon initial contact therebetween.
10. The float-responsive valve as recited in claim 3, wherein said force vector and said bisecting line are at least substantially collinear.
11. The float-responsive valve as recited in claim 3, wherein said actuating lever maintains said flapper in said open position thereof when fluid flows through said flow passage from said second portion thereof to said first portion thereof, and wherein said flapper is moveable beyond said open position to a fully-open position under fluid pressure when fluid flows through said flow passage from said first portion thereof to said second portion thereof.
12. The float-responsive valve as recited in claim 1, wherein said valve actuator maintains said valve element in said open position thereof when fluid flows through said flow passage from said second portion thereof to said first portion thereof, and wherein

said valve element is moveable beyond said open position to a fully-open position under
5 fluid pressure when fluid flows through said flow passage from said first portion thereof
to said second portion thereof.

13. The float-responsive valve as recited in claim 1, wherein said valve body includes
first and second sections that are connected to one another and that have mating bores
formed therethrough to collectively form said first and second portions of said flow
passage.

5 14. The float-responsive valve as recited in claim 13, wherein said valve element is
mounted in a chamber formed by an enlarged end portion of the bore in said first section,
said enlarged end portion forming an inner end of said second portion of said flow
passage.

5 15. The float-responsive valve as recited in claim 13, wherein said first and second
valve body sections are attached to one another by one of a threaded connection and a
bonded connection.

16. The float-responsive valve as recited in claim 13, wherein
said valve is a water softener brine valve configured to be mounted in a brine tank
of a water softener,
said first portion of said flow passage terminates in a port configured to
5 communicate with the interior of the brine tank, and

said second portion of said flow passage terminates in a port configured to communicate with the exterior of the brine tank.

17. A water softener brine valve comprising:

(A) a valve body that has a first port configured to communicate with an interior of a water softener brine tank, a second port configured to communicate with an exterior of the brine tank, and a flow passage connecting said first and second ports to one another;

(B) a valve seat that is disposed in said flow passage;

(C) a flapper that is pivotably mounted in said valve body and that is pivotable from a closed position thereof in which said flapper seats on said valve seat and an open position to permit fluid flow through said flow passage past said valve seat; and

(D) a float-responsive actuating lever that is selectively responsive to operation of a float to pivot about a pivot axis from a first position to a second position in which said actuating lever holds said flapper in said open position, wherein said actuating lever is dimensioned and configured relative to said flapper such that fluid flowing through said flow passage from said second port is essentially incapable of closing said flapper when said actuating lever is in said second position thereof.

18. The brine valve as recited in claim 17, wherein said actuating lever and said flapper are configured such that, when said actuating lever is in said second position and said flapper is pressed against said actuating lever by closing forces imposed on said flapper by fluid flowing from said second port toward said first port, a force vector passes

5 through a primary contact point between said actuating lever and said flapper at a substantially nonnegative angle relative to a bisecting line passing through said pivot axis and said primary contact point.

19. The brine valve as recited in claim 18, wherein said actuating lever has a lobe thereon that at least selectively engages a driven lug on a lower surface of said flapper at said primary contact point.

20. The brine valve as recited in claim 19, wherein at least one of said lobe and said driven lug has an inclined leading edge that engages the other of said lobe and said driven lug upon initial contact therebetween.

21. The brine valve as recited in claim 17, wherein said force vector and said bisecting line are at least substantially collinear.

22. A water softener comprising:

(A) a resin tank;

(B) a brine tank;

(C) a control valve assembly that is connected to said resin tank, said brine

5 tank, a source of untreated water, a drain, and a treated water discharge and that is configured to control fluid flow between the source of untreated water, said resin tank, said brine tank, the treated water discharge, and the drain; and

(D) a water softener brine valve comprising

(1) a valve body that has a first port in fluid communication with the
10 interior of a water softener brine tank, a second port communicating with the
control valve assembly via an inlet/outlet opening in said brine tank, and a flow
passage connecting said first and second ports to one another,

(2) a valve seat that is disposed in said flow passage,

(3) a flapper that is pivotably mounted in said valve body and that is
15 pivotable from a closed position thereof in which said flapper seats on said valve
seat and an open position thereof to permit fluid flow through said flow passage
past said valve seat, and

(4) a float that is disposed in said brine tank and that is configured to
move between a raised position thereof and lowered position thereof as a liquid
20 level in said brine tank rises and falls, and

(5) a float-responsive actuating lever that is coupled to said float and
that is responsive to downward motion of said float from said raised position to
pivot about a pivot axis from a first position in which said actuating lever is
incapable of opening said flapper to a second position in which said actuating
25 lever holds said flapper in said open position thereof, wherein said actuating lever
and said flapper are configured such that, when said actuating lever is in said
second position and said flapper is pressed against said actuating lever by closing
forces imposed on said flapper by fluid flowing through said flow passage from
said second port, a force vector passes through a primary contact point between
30 said actuating lever and said flapper, said force vector being at least generally

collinear with a bisecting line passing through said pivot axis and said primary contact point.

23. The water softener as recited in claim 21, wherein said flapper is configured to be held open by said actuating lever against the resistance of fluid forces flowing through said flow passage during a refill phase of a water softening cycle in which fluid flows through said flow passage from said second port to said first port,

to be held open by fluid pressure when fluid flows through said flow passage from said first port to said second port, and

to close automatically when said float is in said raised position and fluid is not flowing through said flow passage from said second port to said first port.

24. A method of operating a valve, comprising:

(A) moving a valve element into an open position thereof;

(B) in response to downward movement of a float from a raised position thereof to a lowered position thereof, moving a valve actuator from a first position thereof to a second position thereof in which said valve actuator holds said valve element in said open position thereof;

(C) imposing closing forces on an open valve element generated by fluid flowing past said valve element; and

(D) so long as said float remains in said lowered position and said closing forces are imposed on said valve element, transmitting said closing forces through said

valve actuator in a manner that prevents said closing forces from driving said valve actuator from said second position thereof to said first position thereof, thereby holding said valve element in said open position despite the imposition of closing forces thereon.

25. The method as recited in claim 24, wherein said valve actuator comprises an actuating lever which engages said valve element, wherein the moving step comprises pivoting said actuating lever about a pivot axis such that said actuating lever engages said valve element at a primary contact point, and wherein the transmitting step comprises
5 transmitting a force vector that forms a substantially nonnegative angle with a bisecting line passing through said primary contact point and said pivot axis.

26. The method as recited in claim 25, wherein said force vector and said bisecting line are at least substantially collinear.

27. The method as recited in claim 25, wherein said valve element comprises a flapper, and wherein the pivoting step comprises pivoting a lobe on said actuating lever into contact with a driven lug on said flapper.

28. The method as recited in claim 27, wherein the pivoting step comprises engages a leading edge on at least one of said lobe and said driven lug with the other of said lobe and said driven lug upon initial contact therebetween.

29. The method as recited in claim 24, wherein said valve actuator maintains said valve element in said open position thereof when fluid flows through said flow passage from a second portion thereof to a first portion thereof, and wherein said valve element is moveable beyond said open position to a fully-open position under fluid pressure when
- 5 fluid flows through said flow passage from said first portion thereof to said second portion thereof.